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# Foreign Direct Investment, Agglomerations and Demonstration Effects: An Empirical Investigation

Frank Barry, University College Dublin, Holger Görg, University of Nottingham and Eric Strobl, University College Dublin

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# Foreign Direct Investment, Agglomerations and Demonstration Effects: An Empirical Investigation*

Frank Barry
*University College Dublin*

Holger Görg
*University of Nottingham*

Eric Strobl
*University College Dublin*

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**Abstract**

Many previous studies have shown that the localisation of firms can be an important factor in attracting new foreign direct investment into a host country. What has been missing in this literature thus far, however, is an investigation into the reasons why industry clusters attract firms. We distinguish between "efficiency agglomerations" as firms locating close to each other because they can increase their efficiency by doing so, and "demonstration effects", whereby existing firms send signals to new investors as to the reliability of the host country and newly entering firms follow previous firms. In this paper we try to disentangle these two effects, by examining the location of US and UK firms in Ireland. We calculate proxies for "efficiency agglomerations" and "demonstration effects" and include these proxies in an empirical model of the location decision of firms. For US firms, we find that both efficiency agglomeration and demonstration effects are important determinants of entry. For UK firms, however, the evidence is not as clear cut.

JEL classification: F23

Keywords: Foreign Direct Investment, Agglomerations, Demonstration effects

Address for correspondence: Holger Görg, School of Economics, University of Nottingham, Nottingham NG7 2RD, UK. Email: holger.gorg@nottingham.ac.uk

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## 1 Introduction

Economists have recognised the importance of agglomeration benefits for the location of firms for a long time, the standard reference being to Marshall (1920). The implications of agglomerations have recently been analysed extensively in the growing "new economic geography" literature, see, for example, Krugman and Venables (1995, 1996). Following Marshall, the new economic geography literature postulates three reasons for the emergence of agglomerations. Industrial districts in which firms benefit from locating close to each other arise, it is argued, because of (i) knowledge spillovers between firms, (ii) the advantages provided by thick markets in specialised factors, in particular labour, and (iii) the scope for backward and forward linkages between customer and supplier firms.[1] If these conditions exist, firms can increase efficiency by locating close to other firms, leading to agglomeration of industries.

DeCoster and Strange (1993), however, have pointed out that even if these efficiency reasons are not prevalent firms may find it rational to agglomerate spatially. If there is uncertainty about locations in which to invest, investors may exhibit a tendency to imitate each others' location decisions. This arises because investors locating in a "good" location provide a signal to other investors, and to banks which provide the funds for investments. Banks conclude that investments in good locations have higher probabilities of success and provide funding for investments in good locations more forthcoming than for investments in bad locations. As other firms are aware of this choice mechanism, they have an incentive to choose the same "good" location for their investment.

Empirically it is, of course, difficult to distinguish between the "efficiency" factors leading to agglomerations a la Marshall and New Economic Geography, and the

"demonstration effect" as discussed by DeCoster and Strange. Although there have been a few studies investigating the importance of industrial agglomerations for the location of foreign direct investment (FDI) in the host country (see Wheeler and Mody, 1992; Head et al., 1995, 2000; Braunerhjelm and Svensson, 1996, 1998; Barrell and Pain, 1999), these papers do not attempt to assess the relative importance of efficiency agglomeration factors compared to the demonstration effect.

The papers by Head et al. (1995, 2000) are perhaps most closely related to our paper and, therefore, deserve a more detailed description. Specifically, these papers examine the location of Japanese firms across US states using data for the 1980s. The location choice of Japanese firms is modelled by a conditional logit regression and includes a proxy for the effect of the presence of Japanese firms already present in the location, which they refer to as a proxy for "agglomerations". This proxy is defined as the number of Japanese firms in the sector and region. The estimation yields a positive coefficient for the variable which Head et al. take as evidence for the importance of agglomeration economies for the location of Japanese firms. They do not, however, attempt to distinguish the effect of demonstration effects and efficiency agglomerations as discussed above.

In this paper we attempt to shed light on this issue. We conduct an empirical analysis of the factors that attract inward foreign direct investment into the Irish economy, focusing particularly on the importance of efficiency agglomerations and demonstration effects. Krugman (1997) points out that as foreign firms face greater uncertainties than domestic firms in the host country, they may have strong incentives to follow previous investors because of the signal they send as to the reliability of the host country location. In other words, even if the "efficiency" reasons for the development of agglomerations a la Marshall are not important, firms may choose the same locations due to demonstration

effects. Such demonstration effects have been alluded to by both Krugman (1997) and Barry and Bradley (1997) in discussing the strong growth in inward FDI into Ireland over the last 15 years or so.

Barry and Bradley (1997) write that "surveys of executives of newly arriving companies in the computer, instrument engineering, pharmaceutical and chemical sectors indicate that their location decision is now strongly influenced by the fact that other key market players are already located in Ireland" (p. 1804). Krugman (1997) argues that Ireland now enjoys the advantage of being able to demonstrate its reliability as a host country to new investors. In the electronics industry, for example, it is host to “twenty of the top twenty-five US high-technology companies” (White, 2000, p. 290).[2] According to Krugman (1997), this demonstration effect attracts other firms to locate in Ireland in the vicinity of the sector's leading firms.

For a number of reasons Ireland provides a useful test case to investigate the importance of efficiency agglomeration and demonstration effects in attracting inward FDI. First there is the strong presence of foreign-owned multinational companies (MNCs) in the Irish economy, which is evident from data taken from the Irish *Census of Industrial Production*: In 1998, foreign multinationals accounted for 47 per cent of manufacturing employment, 82 per cent of net output and 88 per cent of manufacturing exports. Second is the substantial presence of foreign-owned firms in the high-tech sector, as evident from the data presented in Table 1, allowing us to analyse the relative importance of traditional agglomeration and demonstration effects across sectors differentiated by degree of technology. Third are the differences between firms from the US and the second most predominant source country, the UK. Illustrative differences presented in Table 1 show that the US-owned firms exhibit much higher labour productivity than UK-

owned firms, are much more strongly export-oriented, and are much more likely to be located in high-tech sectors.[3]

*[Table 1]*

In order to investigate whether efficiency agglomeration and demonstration effects may have impacted on inward FDI, we model empirically the location decision of foreign-owned firms. In particular, we focus on firms from the US and the UK. We would expect these two nationality groups to behave differently due to their different average characteristics as pointed out above. We calculate proxies for the effect of efficiency agglomerations and demonstration effects, and include these in the model of foreign firms' location. We find that, for US firms, both efficiency agglomeration and demonstration effects are important factors, while the evidence for UK firms is not as clear-cut.

The remainder of the paper is structured as follows. In Section 2 we present the data used for the empirical analysis. Section 3 outlines the econometric methodology while Section 4 presents the estimation results. Section 5 summarises the main results and concludes.

## 2 Description of the Data

Our main data source for our analysis of the importance of efficiency agglomerations and demonstration effects on entry of foreign firms in Ireland is the *Forfás Employment Survey* of Irish manufacturing firms. This survey has been undertaken annually by Forfás, the policy and advisory board for industrial development in Ireland, since 1973. Data are available to us up to 1996. The survey covers virtually all active manufacturing companies, and the response rate is generally over 99 per cent, providing a sample of over 15,000 firms. For these firms we have information on employment levels,

nationality of ownership, sector of location, and start-up year, which allows us to calculate the number of foreign firms entering the Irish economy in every year. A firm is classified as being foreign-owned if 50 percent or more of its shares are held by foreign owners. Using these data we are able to calculate the number of entrants from the US and the UK per year for 27 manufacturing sectors.[4]

In addition we supplement our employment survey with information from the *Forfás Irish Economy Expenditure Survey* and the *Forfás Survey of Research and Development in Industry* in order to calculate some of the explanatory variables used in the econometric analysis. The former database provides data on input-sourcing behaviour for a sample of large firms (greater than 30 employees from 1983 and greater than 20 employees from 1990 onwards) since 1983. The latter survey has been undertaken since 1986 and provides data on the population of R&D performers with ten or more employees in the manufacturing sector. The use of these two datasets means that in our econometric analysis below we are constrained to analysing the period 1986 to 1996.

Table 2 provides some descriptive statistics relating to the number of US and UK firms based in Ireland. As indicated earlier these firms would appear to represent two different types of foreign firms in Ireland. It is notable that the total number of US firms has grown by 144 percent, while the number of UK firms declined by 54 percent over the period 1973 to 1996. One can also see differences in the sectoral location of firms. While US firms are much more concentrated in modern high-tech sectors (such as machinery, transport and scientific equipment), UK firms are more concentrated in low-tech traditional sectors (e.g., food, textiles & leather, paper & printing). These different characteristics may suggest that US and UK firms also follow different strategies in their location decision, a question that we investigate further below.

*[Table 2]*

## 3 Econometric Model and Methodology

In order to investigate in more detail whether the entry of new foreign firms in Ireland is related to the presence of efficiency agglomerations and demonstration effects, we need to model the location decision of foreign firms. We, therefore, postulate the following empirical model which relates the number of foreign entrants of nationality group *f* (*f* = US, UK), $n^f$, in sector *j* at time *t* to a number of explanatory variables,

$$n_{jt}^f = b_0 + b_1 A_{jt} + b_2 D_{jt} + b_3 X_t + u_{jt} \qquad (1)$$

where *A* and *D* are efficiency agglomeration and demonstration effects respectively, and *X* denotes other observables which may affect $n^f$. Of course, *A* and *D* are unobservable and we need to find appropriate proxies. What is observable, however, is the total spatial localisation of foreign firms, *LOC*, which is due to firms clustering either to benefit from efficiency agglomeration benefits and/or from demonstration effects,

$$LOC = A + D \qquad (2)$$

In other words, we can observe the composite *LOC* but the two components *A* and *D* are unobservable. In order to find appropriate proxies for *A* and *D* we therefore suggest to run the following regression

$$LOC_{jt} = a_0 + a_1 \tilde{A}_{jt} + v_{jt} \qquad (3)$$

where $\tilde{A}$ is a vector of variables to proxy the importance of efficiency agglomeration benefits. Using the result of this regression we estimate the predicted value of the regression $\hat{LOC}$ and the residual $\hat{v}$. We take the former as a proxy for *A* and the latter as a proxy for *D* in the initial regression (1).

Proxies are, of course, always only approximations for the unobservable variable of interest, and we are cautious to point out that particularly $\hat{v}$ is a less-than-perfect proxy for the unobservable *D*. While we focus on efficiency agglomeration and demonstration effects as reasons for the spatial clustering of firms, traditional trade theory would suggest that localisation of industries emerge purely due to endowment reasons. In a nutshell, firms will locate in regions with favourable factor endowments. Our proxy for *D* therefore likely includes demonstration effects as well as endowment driven agglomerations. We control for this in the estimation of the entry model (equation (1)) by including a proxy for endowment driven localisation, similar to Head et al. (1995). Our proxy for *D* should, therefore, in the estimation of equation (1) provide an indication of demonstration effects, after controlling for endowment effects.

We measure the extent of localisation of foreign firms (*LOC*) in sector *j* using (i) the total number of foreign firms present in the sector (as in Head et al. 1995, 2000) and (ii) the (log of) total employment stock in foreign firms in sector *j*. While Head et al. use the number of firms as proxies for localisation variables on the right-hand side we note that this measure does not allow them to distinguish between large and small firms. We feel such a distinction is important for at least two reasons. First the scale of other firms' investments (reflected in employment size in Ireland), rather than the actual number of investments, could represent an important demonstration effect. Secondly, attracting large multinational firms (or "flagship projects") is likely to be more important than attracting smaller firms in order for demonstration effects to emerge. Replacing the number of firms by the employment variable on the right-hand side takes account of the first effect and, if large multinationals are likely to employ higher numbers in their Irish operations than are smaller multinationals, should take account of the second point also.[5]

$\tilde{A}$ includes three variables with which we try to proxy the three efficiency reasons why firms may agglomerate, as discussed above. Firstly, we include the R&D intensity (*spillover*) in a sector in order to proxy for potential knowledge spillovers between firms. This variable takes into account that spillovers arise when one firm's innovative activity leads to new ideas and an enhancement of innovative activity in a second firm without the second firm having to compensate the other inventor.[6] We measure a sector's R&D intensity as the proportion of total employment in R&D active firms. We would expect a positive sign on the coefficient of *spillover*.

A measure of excess job turnover (*turnover*) is the second variable included. This variable should control for the effect of the presence of thick labour markets in an agglomeration. If there are thick markets for specialised labour adjustment costs can be presumed to be low, as labour can move easily and hiring and firing costs are low. In such an environment, workers tend to move more frequently between jobs, thus providing a readily accessible common labour market pool for existing and potential firms within the sector. Hence we choose to calculate the measure as the intra-industry job turnover in excess of inter-sectoral employment shifts, as suggested by Davis and Haltiwanger (1992). A large degree of job turnover indicates low adjustment costs; we would, therefore, expect a positive relationship between *excess* and the presence of efficiency agglomerations.

The third variable is a proxy for the presence of input-output linkages between firms (*link*). We calculate it as total raw materials, intermediate inputs, and services sourced in the Irish economy per employee in a sector. This allows for the fact that firms may agglomerate if there are input-output linkages between customer and supplier firms. We would, thus, expect a positive sign on this variable.

While equation (3) can be estimated using OLS, the dependent variable in equation (1) is a discrete variable and we, therefore, need to employ a count data model to estimate it. The standard method is to assume that the variable is generated by a Poisson distribution of the form

$$\Pr ob(n_{jt}^{f}) = \left(m^{n_{jt}^{f}} e^{-m}\right) \Big/ n_{jt}^{f}! \qquad (4)$$

where $m$ is the conditional mean of the distribution. It is then assumed that the expected value of $n$, $m$ is log linearly dependent on some explanatory variables, and parameter estimates of these variables can be obtained using maximum likelihood techniques. The Poisson model imposes the restriction that the conditional mean of the dependent variable equals its variance. If it is found that this restriction does not hold in the data, one may employ a negative binomial distribution, which allows for "overdispersion" in the data, i.e., the variance of the dependent variable is allowed to exceed the mean. In our econometric analysis below we test for this restriction and find that, in all cases, we cannot reject the assumption that the variance equals its mean.[7] We therefore take the estimates generated by the Poisson estimation as being appropriate.

Apart from the proxies for *A* and *D*, equation (1) includes a number of other control variables. These are the following:[8]

*Relative cost competitiveness of Ireland as a host country* (*comp*). We include a measure of Ireland's relative cost competitiveness as a host country in the EU, similar to Barrell and Pain (1999). For UK companies it is straightforward to calculate such a variable. UK firms are likely to decide between locating in Ireland or remaining in the home country and therefore, relative labour costs between Ireland and the UK may be an adequate measure of cost competitiveness. US companies, by contrast, may be assumed to search for alternative locations in the EU in order to serve the EU market. Since

Ireland and the UK share a number of common characteristics, such as a common language and similar culture, similar labour market institutions, similar location, it may appear reasonable to assume that Ireland competes primarily with the UK for investments from the US. Hence, we measure Ireland's relative cost competitiveness also as relative labour costs between Ireland and the UK. This is calculated as the ratio of real wages and salaries per employee in sector *j* in Ireland relative to the UK, converted to a common currency. To construct the variable we use data from the Irish Census of Industrial Production and the UK Census of Production.

*GDP growth in source country f* (*gdpg*$^{f}$). This variable is intended to control for the foreign supply of FDI, as in Bloningen (1987). The assumption is that growth in the source country is likely to generate a greater supply of FDI. Data for this variable were obtained from the Bureau of Economic Analysis in the US Department of Commerce for US GDP, and Eurostat for the UK data.

*Size of the sector* (*size*). The rationale for including this variable is to control for the fact that one would expect larger numbers of entrants in large sectors. Since the Irish market is very small, and foreign firms mainly locate in Ireland to service the larger European market (see Barry and Bradley, 1997) we measure this variable as the size of the sector in the EU.[9] The variable is calculated in terms of employment size, using data available from the UNIDO database.

*Ireland's comparative advantage* (*adv*). This variable is included to capture the effect of endowments on industry location, as discussed above. All other things equal, foreign firms should be expected to locate where factor endowments are favourable. We postulate that the sectoral distribution of Irish-owned firms reflects this kind of information. We calculate an employment specialisation index as the ratio of the share of

sector *j* employment in Irish-owned firms over total manufacturing employment in Irish-owned firms in Ireland relative to the same share for the whole EU (including domestic and foreign-owned firms),

$$adv_t = \left( E_{tj}^{IRL} \Big/ \sum_j E_{tj}^{IRL} \right) \Big/ \left( E_{tj}^{EU} \Big/ \sum_j E_{tj}^{EU} \right) \qquad (5)$$

where $E_j^{IRL}$ is employment in Irish-owned firms in sector *j* in Ireland, and $E_j^{EU}$ is employment in both domestic and foreign-owned firms in sector *j* in the total EU, using the same datasource as used for the calculation of sectoral size.[10]

## 4 Econometric Results

As pointed out above, firms from the US and the UK appear to represent two very different categories of foreign entrants in Ireland. Due to these differences, we may expect the behaviour and location decisions of entrants of these two nationality groups to be different also. We, therefore, present the results for analysing the effects of efficiency agglomeration and demonstration effects on the entry of firms from these two nationality groups separately.

### 4.1 US entrants

Table 3 presents the results for the estimation of equation (3). Columns (1) and (2) relate to estimations using the number of firms as measures of *LOC* (i.e., localisation of firms) columns (3) and (4) report results based on estimations using the stock of employment as the measure of localisation. Also note that in columns (1) and (3) the localisation measure is calculated using all foreign firms, while (2) and (4) are based on these measures being calculated for US firms only. This distinction should allow us to investigate whether the benefits from efficiency agglomerations and demonstration effects emanate from all foreign firms, or from firms of the same nationality only.

Inspection of the results shows that all estimated coefficients are of the right sign. The measures of knowledge spillovers and labour turnover are statistically significant in all cases, while the measure of linkages is only statistically significant in one case.

*[Table 3]*

Tables 4 and 5 then present the results of estimating equation (1), i.e., analysing the effect of efficiency agglomerations and demonstration effects on the entry of US firms. The results in Table 4 are based on measuring the localisation of firms using firm numbers, while Table 5 is based on localisation of firms calculated as total employment stock. In both tables, the results reported in columns (1) to (3) relate to estimations using the spatial localisation of all foreign firms as a basis for calculating *A* and *D*, while columns (4) to (6) present results for the localisation of US firms only. We also decomposed the data for all manufacturing firms into groups of firms in high-tech and low-tech tech sectors to obtain more homogenous comparison groups. Columns (2) and (5) show results using data on firms in high-tech sectors only, while estimation results in columns (3) and (6) relate to low-tech sectors only.[11]

We find in Table 4 that there is empirical evidence to suggest that, after controlling for possible endowment effects and other factors, both efficiency agglomeration and demonstration effects are important determinants for attracting new US firms. Comparisons of the sizes of the coefficients shows that, for high tech sectors, the coefficient on *A* is larger than that on *D*, implying that the efficiency agglomeration effect appears to be larger than the demonstration effect. Such a difference is not observable for low tech sectors, however. Furthermore, we find evidence for efficiency agglomerations and demonstration effects when we examine the localisation of all foreign firms as well as when looking at US firms only although the coefficients in the latter case

are consistently higher. This may suggest that both effects emanate more strongly from firms of the same nationality as the entrant.

As regards to the other control variables included in the empirical model, we find statistically significant evidence that US entry in the high tech sector decreases as Ireland's relative cost competitiveness vis-à-vis the UK worsens. There is no such evidence for the low tech sector, however. This suggests that US entrants in the high tech sectors are particularly likely to respond negatively to increases in Irish labour costs relative to the UK.

The positive and statistically significant (in three out of six cases) coefficient on *adv* suggests that endowment effects, in addition to efficiency agglomerations and demonstration effects, are also important for the location decisions of US entrants. As theory would predict, US entrants are more likely to locate in sectors in which Ireland has favourable factor endowments. The results on the other two control variables are statistically insignificant indicating that they do not appear to have any impact on the entry of US firms.

*[Table 4]*

Using employment stock rather than firm numbers as a basis for our proxies *A* and *D* produces the results reported in Table 5. In terms of the coefficients on *A* and *D* we find no major changes to the results in Table 4; both are statistically significant, and the efficiency agglomeration effect appears to dominate the demonstration effect. One should note, however, that now the coefficient on *A* is also higher than that on *D* in the low tech sector.

The measure of Ireland's cost competitiveness is still negative for the high tech sector, although it is now only statistically significant (at the ten percent level) in one case. The

measure of comparative advantage shows also different results. It is negative and statistically significant in one case which, if taken at face value, would imply a negative correlation between endowments and industry location. This is clearly contrary to what theory would predict.

*[Table 5]*

### 4.2 UK entrants

The results for the entry of new UK firms into Ireland show somewhat different results on the importance of efficiency agglomerations and demonstration effects. While the results of estimating equation (3), reported in Table 6, are fairly similar to the results we obtained for the US there are a number of differences apparent when inspecting the results of estimating equation (1). These latter results are reported in Tables 7 and 8.

*[Table 6]*

When examining the localisation of all foreign firms (columns (1) – (3)) we find strong evidence for positive effects emanating from demonstration effects, while efficiency agglomeration effects only seem to matter for firms in low tech sectors. Furthermore, limiting ourselves to the effects of localisation of UK firms shows evidence for demonstration effects for firms entering in low tech industries, but not for efficiency agglomerations. There are no such effects apparent for high tech industries. This may suggest that efficiency agglomeration and demonstration effects originate mainly from firms of other nationalities, while UK firms are not that important for the creation of efficiency agglomeration and demonstration effects.

When looking at employment, rather than firm numbers, to proxy firm localisation (Table 8) we find consistently positive and statistically significant evidence for demonstration effects. However, evidence of efficiency agglomeration effects is only to be found in the

case of UK entry in low tech industries. This strengthens the findings in Table 7 that efficiency agglomerations do not seem to matter for UK entrants, in particular in high tech industries. It also shows, however, that a distinction between measuring the localisation of firms in terms of firm numbers or employment stock yields slightly different results.

*[Tables 7 and 8]*

## 5 Summary and Conclusions

It has been established in the literature that the localisation of firms can be an important factor in attracting new foreign direct investment into a host country. What has been missing in the literature thus far, however, is an investigation into the reasons why industry clusters attract firms. On the one hand, new foreign firms may be attracted because they can increase their efficiency by locating close to other firms; this is the reason for agglomerations frequently postulated in the new economic geography literature. Apart from such "efficiency agglomerations" firms might also be attracted by the presence of existing firms because of demonstration effects, whereby existing firms send signals to new investors as to the reliability of the host country.

In this paper we try to disentangle these two reasons for industry localisations, by examining the case of US and UK firms locating in the Irish economy. We calculate proxies for "efficiency agglomerations" and "demonstration effects" and include these proxies in an empirical model of the location decision of firms. For US firms, we find that both efficiency agglomeration and demonstration effects are important determinants of entry. For UK firms, however, the evidence is not as clear-cut. While demonstration effects are important for the location of UK entrants there is no evidence to suggest that efficiency agglomerations matter as well. Our analysis underlines the different

characteristics of US and UK firms in Ireland and shows that these differences are also reflected in the location decisions of firms from the two nationality groups.

On a more general level our distinction between efficiency agglomeration and demonstration effects also has policy implications. If firms are attracted by the former, the government can assist the build up of such agglomerations through educational policies, support of sub-supply industries etc. On the other hand, if firms are only attracted because of demonstration effects, it is important from an economic development point of view to attract a significant number of firms into the host country which are able to signal to other firms the reliability of the host country. As the evidence suggests, Ireland seems to have been able to attract such "flagship projects" at an early stage of development and is now reaping the benefits.

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## Tables

### Table 1: Comparison between US- and UK-owned firms in Ireland (1998)

| Firm Ownership | Number of firms | Proportion of manufacturing employment | Value-added per employee (£000) | Proportion of own gross output exported | **High-tech sectors** | | |
|---|---|---|---|---|---|---|---|
| | | | | | % of firms | % of empl | % of net Y |
| US | 295 | 27% | 258.4 | 97% | 62% | 73% | 69% |
| UK | 122 | 5% | 113.5 | 58% | 39% | 28% | 28% |

Source: Census of Industrial Production

### Table 2: Percentage of firms by sector, US and UK

| Sector | US | | | UK | | |
|---|---|---|---|---|---|---|
| | 1973 | 1985 | 1996 | 1973 | 1985 | 1996 |
| Food, Drink & Tobacco | 9.8% | 6.6% | 6.2% | 18.2% | 19.0% | 21.9% |
| Textiles & Leather | 7.5% | 6.9% | 4.9% | 23.2% | 17.6% | 9.6% |
| Wood & Furniture | 1.5% | 1.0% | 1.5% | 2.5% | 1.0% | 0.0% |
| Paper & Printing | 3.8% | 3.1% | 3.7% | 4.7% | 2.9% | 4.1% |
| Chemicals | 17.3% | 12.5% | 14.5% | 10.0% | 14.3% | 17.8% |
| Rubber & Plastics | 4.5% | 5.2% | 5.2% | 5.0% | 5.7% | 11.6% |
| Non-metallic minerals | 3.0% | 2.1% | 0.9% | 10.7% | 13.8% | 10.3% |
| Metals | 15.8% | 8.7% | 6.5% | 12.2% | 11.0% | 11.6% |
| Machinery | 16.5% | 33.9% | 32.7% | 6.3% | 9.0% | 9.6% |
| Transport Equipment | 5.3% | 4.5% | 7.1% | 3.1% | 2.9% | 1.4% |
| Scientific Equipment | 11.3% | 13.1% | 14.2% | 1.6% | 1.9% | 1.4% |
| Other manufacturing | 3.8% | 2.4% | 2.5% | 2.5% | 1.0% | 0.7% |
| Total Number | 133 | 289 | 324 | 319 | 210 | 146 |

Source: Own calculations using Forfás Employment Survey data

## Table 3: Auxiliary regression for US firms

OLS regression

| | (1) Foreign firm numbers | (2) US firm numbers | (3) Foreign employment | (4) US employment |
|---|---|---|---|---|
| spillover | 56.271 | 27.773 | 1.725 | 1.442 |
| | (10.392)*** | (4.828)*** | (0.604)*** | (0.493)*** |
| turnover | 255.994 | 107.392 | 13.598 | 8.588 |
| | (40.934)*** | (19.017)*** | (2.381)*** | (1.943)*** |
| link | 0.262 | 0.053 | 0.003 | 0.002 |
| | (0.075)*** | (0.035) | (0.004) | (0.004) |
| constant | -30.859 | -16.364 | -0.778 | -0.949 |
| | (8.413)*** | (3.908)*** | (0.489) | (0.399)** |
| Observations | 250 | 250 | 250 | 250 |
| $F(ß_i=0)$ | 22.03*** | 18.82*** | 12.17*** | 8.20*** |
| $R^2$ | 0.20 | 0.18 | 0.12 | 0.08 |

Notes: Standard error in parentheses.

*** = statistically significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

## Table 4: Results of entry regression for US firms: firm numbers

Poisson regression

| | *LOC*: all foreign firms | | | *LOC*: only US firms | | |
|---|---|---|---|---|---|---|
| | (1) All | (2) High tech | (3) Low tech | (4) All | (5) High tech | (6) Low tech |
| $A_t$ | 0.036 | 0.036 | 0.031 | 0.071 | 0.060 | 0.234 |
| | (0.006)*** | (0.009)*** | (0.018)* | (0.016)*** | (0.026)** | (0.062)*** |
| $D_t$ | 0.020 | 0.007 | 0.025 | 0.047 | 0.028 | 0.246 |
| | (0.003)*** | (0.004)* | (0.017) | (0.006)*** | (0.008)*** | (0.067)*** |
| $comp_t$ | -0.722 | -2.641 | -0.453 | -0.507 | -2.367 | 0.305 |
| | (0.643) | (1.058)*** | (1.115) | (0.643) | (1.061)** | (1.137) |
| $gdpg^{US}_t$ | 4.410 | 10.887 | 11.283 | 3.732 | 7.544 | 9.427 |
| | (7.132) | (8.402) | (15.261) | (7.188) | (8.489) | (15.713) |
| $adv_t$ | -0.234 | 4.811 | 0.364 | 0.062 | 4.461 | 0.512 |
| | (0.144) | (2.876)* | (0.223) | (0.154) | (2.579)* | (0.252)** |
| $size_t$ | -0.2e-07 | 0.8e-07 | -3.9e-07 | -0.4e-07 | 0.6e-07 | -16.4e-07 |
| | (1.3e-07) | (2.1e-07) | (5.8e-07) | (1.3e-07) | (1.8e-07) | (5.9e-07)*** |
| constant | -1.559 | -1.117 | -2.724 | -1.639 | -0.889 | -3.373 |
| | (0.714)** | (1.798) | (1.109)** | (0.722)** | (1.627) | (1.111)*** |
| Observations | 250 | 60 | 190 | 250 | 60 | 190 |
| $LR(ß_i=0)$ | 212.59*** | 76.58*** | 14.97*** | 234.90*** | 84.32*** | 27.23*** |
| $R^2$ | 0.36 | 0.32 | 0.08 | 0.40 | 0.35 | 0.14 |

Notes: Standard error in parentheses.

*** = statistically significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

## Table 5: Results of entry regression for US firms: employment

Poisson regression

| | *LOC*: all foreign firms | | | *LOC*: only US firms | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | All | High tech | Low tech | All | High tech | Low tech |
| $A_t$ | 0.873 | 0.774 | 0.923 | 0.805 | 0.703 | 1.501 |
| | (0.146)*** | (0.186)*** | (0.310)*** | (0.235)*** | (0.315)** | (0.545)*** |
| $D_t$ | 0.626 | 0.462 | 0.552 | 0.647 | 0.417 | 0.894 |
| | (0.063)*** | (0.106)*** | (0.112)*** | (0.055)*** | (0.079)*** | (0.119)*** |
| $comp_t$ | 0.119 | -1.518 | 0.170 | -0.336 | -1.678 | -0.335 |
| | (0.734) | (1.101) | (1.266) | (0.702) | (1.043)* | (1.285) |
| $gdpg^{US}_t$ | 3.393 | 6.352 | 10.048 | 6.714 | 12.734 | -12.622 |
| | (6.750) | (8.080) | (14.366) | (6.854) | (8.010) | (15.950) |
| $adv_t$ | -0.396 | 2.236 | 0.278 | -0.088 | 2.414 | 0.117 |
| | (0.139)*** | (2.770) | (0.248) | (0.143) | (2.602) | (0.273) |
| $size_t$ | -0.5e-07 | -1.6e-07 | -3.5e-07 | -0.2e-07 | -0.5e-07 | -1.2e-07 |
| | (1.2e-07) | (2.0e-07) | (3.4e-07) | (1.2e-07) | (1.8e-07) | (3.0e-07) |
| constant | -2.797 | -1.292 | -4.136 | -1.896 | -0.720 | -2.675 |
| | (0.825)*** | (1.636) | (1.313)*** | (0.742)*** | (1.593) | (1.171)** |
| Observations | 250 | 60 | 190 | 250 | 60 | 190 |
| LR($ß_i$=0) | 262.63*** | 93.34*** | 40.93*** | 312.28*** | 105.54*** | 77.04 |
| $R^2$ | 0.45 | 0.39 | 0.22 | 0.53 | 0.44 | 0.40 |

Notes: Standard error in parentheses.

*** = statistically significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

## Table 6: Auxiliary regression for UK firms

OLS regression

| | (1) Foreign firm numbers | (2) UK firm numbers | (3) Foreign employment | (4) UK employment |
|---|---|---|---|---|
| spillover | 56.271 | 5.317 | 1.725 | 0.428 |
| | (10.392)*** | (2.188)** | (0.604)*** | (0.374) |
| turnover | 255.994 | 20.342 | 13.598 | 3.840 |
| | (40.934)*** | (8.620)** | (2.381)*** | (1.475)*** |
| link | 0.262 | 0.093 | 0.003 | -0.003 |
| | (0.075)*** | (0.016)*** | (0.004) | (0.003) |
| constant | -30.859 | -0.787 | -0.778 | -0.080 |
| | (8.413)*** | (1.771) | (0.489) | (0.303) |
| Observations | 250 | 250 | 250 | 250 |
| $F(ß_i=0)$ | 22.03*** | 13.69*** | 12.17*** | 3.03*** |
| $R^2$ | 0.20 | 0.13 | 0.12 | 0.02 |

Notes: Standard error in parentheses.
*** = statistically significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

## Table 7: Results of entry regression for UK firms: firm numbers

Poisson regression

| | *LOC*: all foreign firms | | | *LOC*: only UK firms | | |
|---|---|---|---|---|---|---|
| | (1) All | (2) High tech | (3) Low tech | (4) All | (5) High tech | (6) Low tech |
| $A_t$ | 0.015 | -0.013 | 0.070 | 0.064 | 0.152 | 0.047 |
| | (0.009) | (0.027) | (0.019)*** | (0.056) | (0.175) | (0.070) |
| $D_t$ | 0.017 | 0.023 | 0.077 | 0.079 | 0.041 | 0.096 |
| | (0.004)*** | (0.010)** | (0.018)*** | (0.017)*** | (0.043) | (0.031)*** |
| $comp_t$ | -0.045 | -1.642 | 0.739 | -0.142 | -2.233 | 0.494 |
| | (0.784) | (1.861) | (0.981) | (0.865) | (2.036) | (1.141) |
| $gdpg^{UK}_t$ | 6.517 | 13.537 | -2.267 | 5.204 | 18.925 | -0.013 |
| | (5.926) | (11.805) | (7.040) | (5.950) | (11.685) | (7.097) |
| $adv_t$ | 0.284 | -3.826 | 0.096 | -0.010 | 2.240 | -0.003 |
| | (0.144)** | (5.968) | (0.198) | (0.156) | (5.529) | (0.204) |
| $size_t$ | 0.6e-07 | -2.9e-07 | -13.1e-07 | 4.0e-07 | 2.2e-07 | 3.4e-07 |
| | (2.0e-07) | (4.6e-07) | (5.3e-07)** | (1.6e-07)*** | (3.8e-07) | (3.1e-07) |
| constant | -2.599 | 1.838 | -3.222 | -2.433 | -1.774 | -2.858 |
| | (0.810)*** | (3.841) | (0.977) | (0.833)*** | (3.455) | (1/050)*** |
| Observations | 250 | 60 | 190 | 250 | 60 | 190 |
| $LR(ß_i=0)$ | 40.81*** | 13.26** | 50.48*** | 41.85*** | 8.54 | 35.89 |
| $R^2$ | 0.12 | 0.15 | 0.21 | 0.13 | 0.10 | 0.15 |

Notes: Standard error in parentheses.
*** = statistically significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

## Table 8: Results of entry regression for UK firms: employment

Poisson regression

| | *LOC*: all foreign firms | | | *LOC*: only UK firms | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | All | High tech | Low tech | All | High tech | Low tech |
| $A_t$ | 0.595 | 0.079 | 0.908 | 1.606 | 3.148 | 1.878 |
| | (0.221)*** | (0.480) | (0.273)*** | (0.851)** | (2.519) | (1.005)* |
| $D_t$ | 0.501 | 0.426 | 0.600 | 0.706 | 0.869 | 0.660 |
| | (0.082)*** | (0.218)** | (0.103)*** | (0.069)*** | (0.203)*** | (0.079)*** |
| $comp_t$ | 0.579 | -0.787 | 1.497 | 1.162 | 0.539 | 1.839 |
| | (0.866) | (1.951) | (1.067) | (0.888) | (2.183) | (1.165) |
| $gdpg^{UK}_t$ | 5.459 | 15.853 | 0.229 | 2.575 | 2.786 | -0.134 |
| | (5.699) | (11.360) | (6.681) | (5.938) | (12.581) | (7.229) |
| $adv_t$ | 0.143 | 0.877 | -0.327 | 0.166 | 4.547 | 0.141 |
| | (0.136) | (5.059) | (0.202) | (0.166) | (5.178) | (0.227) |
| $size_t$ | -0.7e-07 | -0.5e-07 | 3.8e-07 | 4.7e-07 | 2.1e-07 | 6.8e-07 |
| | (1.7e-07) | (3.9e-07) | (2.5e-07) | (1.5e-07)*** | (3.2e-07) | (2.5e-07)*** |
| constant | -3.677 | -1.900 | -4.844 | -4.811 | -6.469 | -5.749 |
| | (0.980)*** | (3.313) | (1.156)*** | (1.235)*** | (4.656) | (1.504)*** |
| Observations | 250 | 60 | 190 | 250 | 60 | 190 |
| LR($ß_i$=0) | 68.31*** | 11.77* | 70.15*** | 129.12*** | 30.63*** | 103.08*** |
| $R^2$ | 0.21 | 0.14 | 0.29 | 0.39 | 0.35 | 0.43 |

Notes: Standard error in parentheses.

*** = statistically significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

## Notes

1 See Ottaviano and Puga (1998) and Fujita and Thisse (1996) for a fuller discussion of the reasons for agglomerations.

[2] Firms with operations in Ireland include Compaq, Dell, Digital Equipment, Gateway Computers, Hewlett Packard, IBM, Intel, Microsoft and Netscape.

[3] In line with material presented later in the paper, these broad sectors are: Chemicals and Pharmaceuticals, Machinery and Equipment, Transport Equipment and Electrical and Optical Equipment.

[4] The sectoral classification is based on a comparison of ISIC and NACE sectoral classification. We linked these two sectoral classifications in order to be able to link the data used in the analysis below.

[5] Support for the latter hypothesis emerges from the database described in Pavelin (2000), on the 300 or so leading firms in the EU (i.e. the top five firms in each 3-digit industry). These data display a positive correlation between foreign firms' relative size rankings in their sector of activity in Ireland and in the overall EU (though size in this database refers to production rather than employment).

[6] This is the definition of knowledge spillovers used by, for example, Branstetter (2000).

[7] See Bloningen (1997) and Coughlin and Segev (2000) for recent discussions of the Poisson and negative binomial models, and applications in the analysis of location decisions of FDI. Note that, strictly speaking, the Poisson specification is a special case of the negative binomial in which the overdispersion parameter is equal to zero. Preliminary regressions, in which we estimated equation (1) using negative binomial regression produced results which are quantitatively and qualitatively similar, suggesting that our choice of estimation technique does not bias our results.

[8] In preliminary regressions we also included sectoral dummies in the estimation of equation (1) to control for sector-specific fixed effects. Tests indicated, however, that we cannot reject the hypothesis that all coefficients of the sectoral dummies were jointly equal to zero. We conclude therefore that the specification without sectoral dummies, the results of which are reported below, is preferable.

[9] To be precise, the variable is calculated using data for France, Germany, Italy, the Netherlands and the UK due to data constraints.

[10] This measure of comparative advantage (see also Barry and Hannan, 1996) also allows us to take into account that foreign firms may be attracted to a sector simply because Ireland has a traditional comparative advantage in that sector. Milner and Pentecost (1996) and Driffield and Munday (2000) show that revealed comparative advantage has been an important determinant of inward FDI in the UK.

[11] The classification of sectors into high tech and low tech is based on an OECD classification as used by Kearns and Ruane (2001). Accordingly, high tech sectors are Aerospace, Computers & Office machinery, Electronics & Communications, Pharmaceuticals, Scientific Instruments, Electrical Machinery, Motor Vehicles, Chemicals, Non-electrical Machinery.